Claim 1 has been amended to more particularly describe the novel aspects of the present invention. Specifically, the amended claim points out the distinction that the gas metering tube of the present invention is elongated. In addition, claim 1 now claims a gas metering tube that promotes substantially uniform delivery of the gas along "substantially the length" of the outermost tube "over a range of operating conditions" by creating a "substantially uniform backing pressure over substantially the length of the innermost tube."

Claim 13 has been amended to clarify certain informalities, to correct certain definitions of physical properties of the gas metering tube, and to provide proper antecedent basis.

The Examiner rejects claims 13-16 under 35 U.S.C. §112, second paragraph as being indefinite for failing to particularly point out and distinctly claim the subject matter which the Applicant regards as the invention due to some discrepancies in the definitions of properties. "Na_{port}" is a typographical error that has been corrected to "NA_{port}" in amended claim 13. Definitions of D_{eff} and D_{in} are also provided. Support for these changes is found in the specification, for example at page 8, line 5 and page 9, line 5. Applicant submits that the requested amendment to claim 13 does not constitute new matter.

The Examiner rejects claims 1-16 under 35 U.S.C. §112, second paragraph as being indefinite for failing to particularly point out and distinctly claim the subject matter which the Applicant regards as the invention. The Examiner objects to the use of "effective annular space," and specifically to "effective." Applicant traverses this rejection and submits that the claims are not indefinite. The word "effective" is used frequently throughout the specification, specifically for example, at page 9, line 5. Its use with regard to the annular space is specifically defined at page 13, lines 23-24 and Equation 1. The annular space created between two axially nested tubes is defined by an "effective" diameter – the diameter of a tube with the same cross sectional area as the annulus. This term is in common usage in the fields of gas sampling and metering. Thus, Applicant respectfully submits that claims 1-16 are not indefinite.

The Examiner rejects claims 1-16 under U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the Applicant regards as the invention. The Examiner objects to the use of "substantial length." Applicant has amended claim 1 to recite "substantially the length" for clarification. Antecedent basis for this amendment is found throughout the specification, for example at page 6, line 27

and at page 7, lines 16-17. Applicant submits that the requested amendment to claim 13 does not constitute new matter.

The Examiner rejects claims 1, 6, 7, 9, 11, and 12 under 35 U.S.C. §102(b) as being anticipated by Kawakami Soichiro (JP61-37969). Applicant traverses this rejection and submits that the amended claims are patentable over Soichiro. Applicant has obtained an English translation of the Soichiro reference, a copy of which is provided herewith for the Examiner's reference.

Soichiro teaches a cylindrical cathode assembly for use in creating a plasma for chemical vapor deposition. Note that in plasma chemical vapor deposition, a plasma is created in a substantially spherical region surrounding the electrode spark point. The teaching of Soichiro is directed toward providing a constant, even flow of plasma gases to a substantially spherical volume via an annular injector incorporated into the cathode assembly. The figures and descriptions provided in Soichiro illustrate the distinct differences between the prior art and the current invention. Note in Fig. 1 and Fig. 4 that the Soichiro apparatus has a fairly squat aspect ratio (diameter to length) consistent with its intended application for delivery of gases to a volume. In Fig. 6, the deposition substrate 44 is positioned at the end of the cathode and oriented perpendicularly to the cathode's cylindrical axis as described in the "Object of the Invention" section (second paragraph): "the active reaction gas is fed uniformly and consistently to the substrate disposed in a facing arrangement with the cathode. One of ordinary skill in the art would come to the conclusion from reading Soichiro that a gas delivery device with a large length to diameter ratio would promote creation of the plasma region at a greater than optimal distance from the substrate target.

In contrast, Applicant's claimed invention is directed to a gas metering tube that delivers gas at a uniform rate along the length of an elongated tube. Flow is not directed out the end of the tube, but rather gas is delivered perpendicularly to the axis of the tube as noted at page 10, line 10 of the specification. As stated at page 4, line 23 to page 5, line 2 of the original specification and in the final line of the proposed amendment to claim 1, the current invention addresses the need for linear gas injectors that provide stable, uniform gas flow over the length of the injector under a wide range of operating conditions, such as temperature, pressure, flow rate, and the like. Support for these additions to the claim are provided in the specification, such as at

page 7, lines 11-12 and at page 10, line 26. Applicant submits that the requested amendments to claim 1 do not constitute new matter.

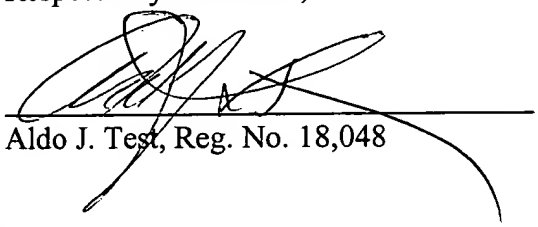
The Examiner rejects claims 2-5, 8, 10, and 13-16 under U.S.C. §103(a) as being unpatentable over Kawakami Soichiro (JP61-37969). Applicant respectfully submits that the present invention is patentable over Soichiro. The Examiner contends that it would have been obvious to one of ordinary skill in the art at the time the invention was made to vary either the dimensions (L, D) of the gas delivery metering tube or vary the distribution (Na_{port}) and/or the dimension (d, $A_{port/tube}$) of the orifices and/or tube dimensions.

Soichiro neither teaches nor suggests extension or modification of his invention to the delivery of gases over substantially the length of an elongated gas metering tube over a range of operating conditions. The two applications differ greatly and the teaching of Soichiro regarding solution of one problem, namely the delivery of gases to a three dimensional volume, are in no way directly applicable to solution of the problems addressed by the gas metering tube of the present invention. The gas metering tube of the present invention provides uniform delivery of gases radially from the tube and does so independently of operating conditions such as gas flow rate, temperature, and backing pressure. The relative and absolute dimensions of the components of the current invention recited in the specification and, for example, in claim 13 were determined through extensive experimentation, numerical modeling, and engineering analysis of non-linear turbulent flows inside candidate gas metering tubes. A small sampling of these experiments are described in detail on pages 13 to 17 of the Specification and illustrated in Figure 4. Soichiro is entirely silent on the issue of delivering gases at a uniform rate along the length of the gas metering tube. Additionally, no mention is made and no teachings are presented that would have informed one of ordinary skill in the art at the time of the current invention of the design requirements necessary to maintain uniformity of the gas delivery profile along the length of a gas metering tube independent of gas flow rate, temperature, pressure and other operating conditions. As noted above, the flow conditions and gas delivery requirements for the cathode assembly taught by Soichiro are substantially different from, and furthermore do not suggest, those of the current invention.

Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached page is captioned "Version with markings to show changes made".

Based on the foregoing, Applicant respectfully submits that the application is now in condition for allowance. If any matters can be resolved by telephone, the Examiner is invited to call the undersigned attorney at the telephone number listed below.

Respectfully submitted,



Aldo J. Test, Reg. No. 18,048

FLEHR HOHBACH TEST ALBRITTON & HERBERT LLP
4 Embarcadero Center, Suite 3400
San Francisco, CA 94111-4187
Telephone: (650) 494-8700
Facsimile: (650) 494-8771

VERSION WITH MARKINGS TO SHOW CHANGES MADE

Please amend the claims as follows. All pending claims are included for the Examiner's convenience.

1. (Amended) A gas delivery metering tube for delivering a gas, comprising:

at least one innermost and outermost axially aligned, elongated, nested tubes having an effective annular space formed between said at least one innermost and outermost nested tubes;

one or more arrays of orifices formed in each of said at least one innermost and outermost nested tubes and extending along the substantial length of each of said tubes;

wherein the one or more arrays of orifices formed in said innermost tube establish a substantially uniform backing pressure [is created within and] along [the] substantially the length of the innermost tube, thereby promoting substantially uniform delivery of the gas out of the orifices in the outermost tube and along [the] substantially the length of the outermost tube over a range of operating conditions.

2. (unchanged) The gas delivery metering tube of claim 1 wherein the effective annular space has an effective diameter D_{eff} and the innermost tube has an inner diameter D_{in}, and D_{eff} and D_{in} are within a factor of three of each other.

3. (unchanged) The gas delivery metering tube of claim 2 wherein D_{eff} is approximately equal to D_{in}.

4. (unchanged) The gas delivery metering tube of claim 1 wherein a ratio of the surface area of the outermost tube to the total cross sectional area of the orifices formed in said outermost tube is equal to or greater than approximately 10.

5. (unchanged) The gas delivery metering tube of claim 4 wherein said ratio is greater than 100.

6. (unchanged) The gas delivery metering tube of claim 1 wherein said metering tube is used in a chemical vapor deposition system.

7. (unchanged) The gas delivery metering tube of claim 1 wherein gas is supplied to one end of the innermost nested tube.

8. (unchanged) The gas delivery metering tube of claim 1 wherein the innermost tube has a length and a diameter and the ratio of the length to the diameter is in the range of approximately less than 70.

9. (unchanged) The gas delivery metering tube of claim 1 wherein the nested tubes are cylindrical.

10. (unchanged) The gas delivery metering tube of claim 1 wherein the nested tubes are rectangular.

11. (unchanged) In combination, the gas delivery metering tube of claim 1 and at least one injector assembly having at least one port for receiving said gas delivery metering tube.

12. (unchanged) In combination, the gas delivery metering tube of claim 1 and at least one shield assembly having at least one plenum for receiving said gas delivery metering tube.

13. (Amended) The gas delivery metering tube of claim 1 wherein the innermost tube has the following properties:

$L/D < 70$

$D/d \approx > 10$

$[Na_{port}]\underline{NA}_{port}/A_{tube} \approx \leq 1$

where L is the length and D is the diameter of the innermost tube, d is the diameter of one orifice in said array of orifices in said innermost tube, N is the number of orifices in the innermost tube,

A_{port} is the cross sectional area of each of said orifices, and A_{tube} is the area of said innermost tube; and

the outermost tube has the following properties:

D_{eff} and D_{in} are within a factor of three of each other

$SurfaceArea_{outer}/NA_{outer} \approx 10$ or more

where D_{eff} is the effective diameter of the effective annular space, $SurfaceArea_{outer}$ is the surface area of the outermost tube, [and] NA_{outer} is the total cross sectional area of all of the orifices in the outermost tube, and D_{in} is the inner diameter of the innermost tube.

14. (unchanged) The gas delivery metering tube of claim 13 wherein D_{eff} is approximately equal to D_{in}.

15. (unchanged) In combination, the gas delivery metering tube of claim 13 and at least one injector assembly having at least one port for receiving said gas delivery metering tube.

16. (unchanged) In combination, the gas delivery metering tube of claim 13 and at least one shield assembly having at least one plenum for receiving said gas delivery metering tube.

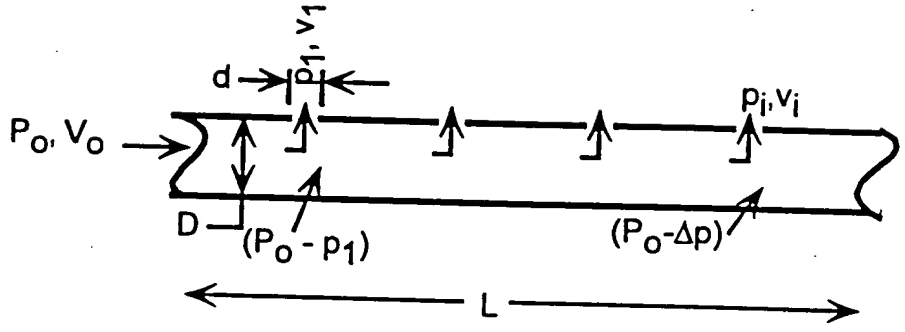


Figure 1

Prior Art

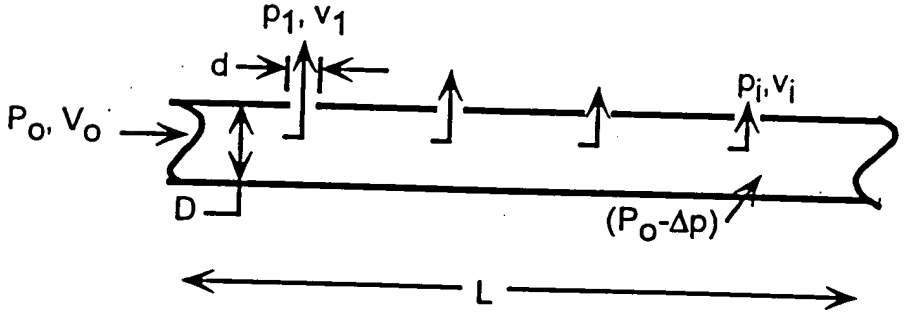


Figure 2

Prior Art

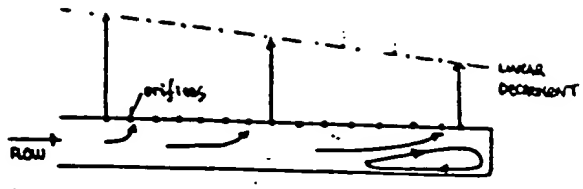


Figure 3a

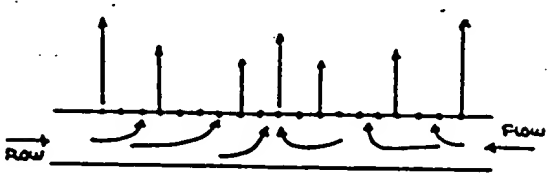


Figure 3b

Prior Art

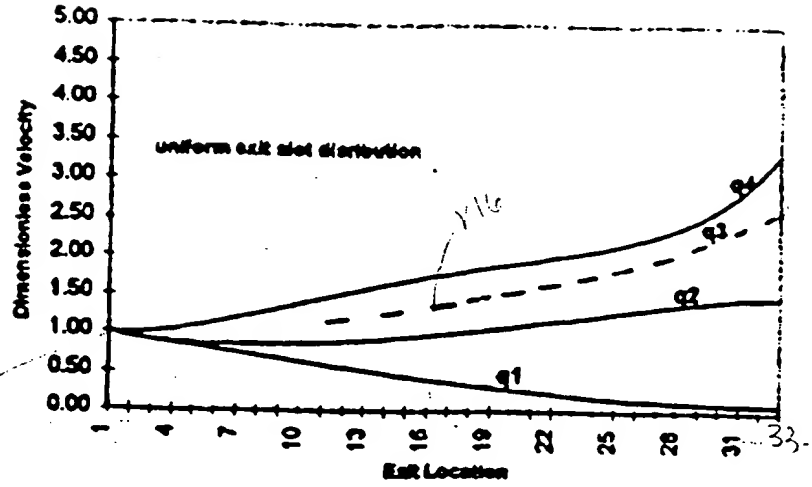


Figure 4

Prior Art